Weatherwise

The Drought-Flood Story

Top Temperatures

Hurricane Detection by Radar

AWA Meets at Mt. Washington

Vol. I, No. 4 August 1948

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE" — BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

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If a Hurricane Strikes...

WHEN WARNINGS of an approaching hurricane are issued, the following safety measures are recommended by the U. S. Weather Bureau. Weathermen everywhere should be prepared to advise neighbors and friends of these measures in the case of a hurricane emergency.

1. Keep your radio on and listen for late warnings and advisories.

2. Pay no attention to rumors. Rely only on official Weather Bureau advices and warnings.

3. Get away and stay away from low-lying beaches or other locations which may be swept by high tides or storm waves. If your only passage to high ground is over a road likely to be under water during a severe storm, then leave early. Don't run the risk of being marooned.

4. If your house is up out of danger of high tide and is well built (securely anchored to foundation with a good roof also securely fastened) then it is probably the best place to weather out the storm.

5. Board up windows or put storm shutters in place. When you board up use good lumber securely fastened. Makeshift boarding may do more damage than none at all. Have strong bracing for outside doors.

6. Get in extra food, especially things which can be eaten without cooking or with very little preparation. Remember that electric power may be off and you may be without refrigeration.

7. If emergency cooking facilities are necessary, be sure they are in working order.

8. Sterilize the bathtub and fill it with water. Also sterilize and fill all jugs, bottles, cooking utensils and other containers, as water service may be interrupted. Even for some time after service has been restored it may be wise to boil drinking water, unless you are sure the supply received from the city's water mains is safe.

9. Have a flashlight in working condition and keep it handy.

10. Check on everything that might blow away or be torn loose. Garbage cans, garden tools, signs, porch furniture, awnings, and other objects become weapons of destruction in hurricane winds. Store them all inside if possible. Loose objects on the roofs of buildings are especially dangercus.

11. Be sure that a window or door can be opened on the lee side of the house . . . the side opposite the one facing the wind.

12. If the center or "eye" of the storm passes directly over, there will be a lull in the wind lasting from a few minutes to half an hour or more. Stay in a safe place. Make emergency repairs during the lull if necessary, but remember the wind will return suddenly from the opposite direction, frequently with even greater violence.

13. Be calm. Your ability to meet emergencies will inspire and help others.

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Cover: The fury of a hurricane lashes the coast of Florida near Miami. Photo by the Miami **Daily News.**

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Huracan*—Evil Spirit of the Tropics

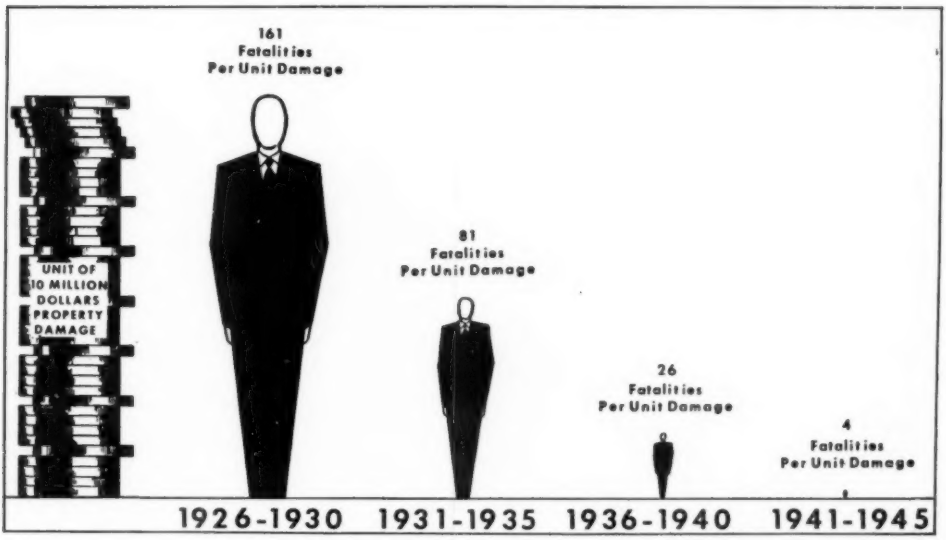
I. R. TANNEHILL, CHIEF, SYNOPTIC AND FORECAST DIVISION,
U. S. WEATHER BUREAU

THE HURRICANE is still a mystery. What have we done in the last decade to come nearer to the answer? Two things: we have made great progress in preventing loss of life, and we have probed the interior of the hurricane with a new approach and completed data on a scale, quantitatively and qualitatively, greater than in any similar period.

The diagram shows what has been done in saving human life. We had another bad hurricane season in 1947, and we kept pace with the extraordinary lifesaving performance of the preceding five years. We can't better that record very much as there is little room for improvement, but we find a different problem as we turn our attention to prevention of property damage on our eastern and southern coasts, where more and more of the nation's industrial wealth is being concentrated.

Success in saving of life is explained by more accurate and more complete information, more timely distribution of warnings, and the systematic removal of large sections of the population from areas exposed to threatening storms. On the other hand, much of our property, including crops, is immovable. It must stand up to the fury of the hurricane or be reckoned as millions of dollars in storm damage. There are two ways of reducing the economic toll. First, accurate warnings farther in advance would help in protecting valuable equipment and other property which can't be moved or made safe on short notice; second, we have a serious problem in connection with industrial shutdown to protect employees, for this becomes very costly. An hour's time in coastal industry is reckoned in hundreds of thousands of dollars. We must look for progress in the

*The word hurricane is derived from *huracan* of the Arawak-speaking Indians of the West Indies. Huracan was the evil spirit of the Tainos, an Indian tribe of extinct aborigines of the Greater Antilles and the Bahamas.



This chart illustrates how improved Weather Bureau hurricane warning service during the past two decades has resulted in diminishing numbers of hurricane fatalities as compared with each unit of 10 million dollars property damage.

planning stage and gear protective measures to the requirements of modern industry. These needs point to the importance of better forecasting farther in advance, and pinpoint accuracy in placing the warning flags.

Looking back at these few short years during and following the war, we see that the bulk of our progress has been on the observation side. No bad hurricanes have been lost for long in blank spaces on the weather maps. Rarely did a hurricane even come near slipping up on us. We knew where they were and about how bad they were. That is half of the battle. Airplane reconnaissance, rasondes, rawins, sferics, microseisms, and radar have helped a lot. But these methods

The initial havoc of a hurricane striking the Florida coast, here pictured, is followed by the flooding and destruction of dwellings far inland as well as on the shore, with possible loss of life by those who have failed to heed the storm warnings.

are not forecasting methods. We still depend on the forecasting skill of the men who study the maps. Better forecasting skill comes slowly, for there are many things we don't understand. The why of hurricane development and movement is poorly understood. Even the cause of the hurricane is still inadequately known.

One of the mysteries is why we don't have a dozen or more hurricanes every day in the hurricane season. There is plenty of warm ocean, an excess of moisture, high air temperature, and opposing winds in the trades, all of which seem to be contributing factors. Yet, days and weeks go by and nothing much happens. June, July, and August have passed in some years with no disturbance of consequence. Many technical explanations have been offered, but no really convincing reason has come to light. Then again, we do not know what becomes of the vast amount of air that flows inward at the bottom, while the pressure of the atmosphere is falling in the storm area. We know that it is forced upward in a tremendous stream with condensation and rainfall in staggering proportions, but the vast mechanism which brings the air inward, carries it upward, and throws it out at the top is imperfectly understood. All the while, the great storm moves forward, bringing new ocean areas into its orbit, and we have no rules that we can apply — nothing but experience and skill gained from year to year in forecasting and studying maps of other great storms in the tropics.

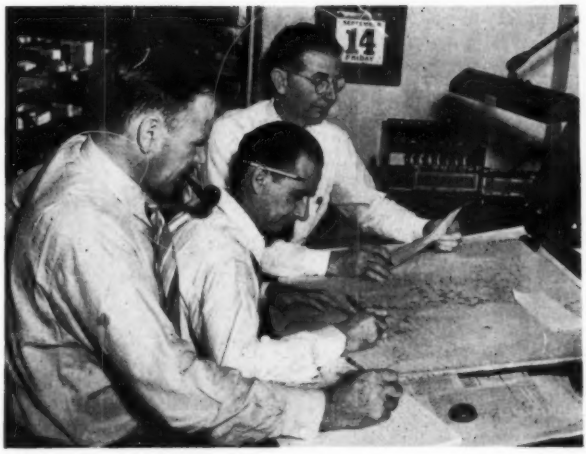
To be sure, skill and experience are accomplishing a great deal. The diagram shows that fact without question. Value of human life can't be calculated. Hurricane forecasters, backed by observers skilled in every method of storm detection, are saving thousands of lives every year. Looking back on the most progressive and successful five years of hurricane forecasting in history, we see that a big job remains — to put together all these new facts, to gather more of the same, and to come up with answers to the how and why of hurricane development and movement. Then we can extend the time range of accurate warnings and make pinpoint predictions for our growing industrial areas in the hurricane zone.

It ought to be easier to learn the secrets of the storm than to find the answer to the techniques of the enemy in time of war. There, every war brings new weapons, new tactics, new strategy, but in tropical storms, so far as we know, nature is using the same old tactics that brought hurricanes to the West Indies in the days of Columbus and before. So varied is the attack and so complicated, that she can repeat it five to 10 times a year and leave us bewildered. This is the challenge we face in the coming decade. Hurricane forecasting must develop from an art into a science.

The prospects are good. The new types of observations we are collecting will provide clues and, as they accumulate, we may expect an increasingly better understanding of the hurricane and therefore more accurate forecasting farther ahead.

FINDING AND TRACKING THE HURRICANE

MILTON L. BLANC
AND
ERNEST CARSON
U. S. WEATHER BUREAU



Grady Norton, W. O. Johnson, and Robert L. Redus plotting and studying weather maps at Hurricane Center, Miami, Fla., during the storm of September, 1945. U. S. Weather Bureau photograph.

THE HISTORY of the Weather Bureau's Hurricane Warning Service is in many ways the history of meteorology in this country. Each advance in one has been associated with an advance in the other. From the very beginning the issuing of storm warnings for ships on the Great Lakes and at sea and in coastal areas has been a basic part of the Weather Bureau's responsibility.

The advent of wireless communication with merchant vessels was quickly adapted to the collection of weather reports. On December 3, 1905, the Weather Bureau received its first radio weather observation from a ship at sea. Since that time, except for periods during the wars when radio silence blacked out most of the area, reports from selected ships traveling in the Caribbean, Gulf, and Atlantic have aided meteorologists to plot and forecast storms. At the present time reports are regularly received four times a day from ships of American and foreign registry under arrangements based on international agreement in the International Meteorological Organization. In addition, special reports are received whenever ships encounter severe storm conditions. Some of the principal ship routes from which reports are received are shown on the large map on page 75.

In addition to reports from ships, it is necessary to collect regular reports from island stations in the hurricane area. The Spanish-American War was a factor in making this possible. Authority to operate reporting stations in the West Indies was given by Congress in 1898 as a measure to protect our forces from hurricane damage. On that foundation has been built a reporting system which is today an important part of the hurricane warning service. In co-operation with the other governments concerned, regular reports are collected from the Bahamas, from Cuba, and eastward along the great chain of islands that curves down toward the coast of South America to bracket the Caribbean on the east. Many storms have made their first appearance on weather maps as they approached the strategically located Windward Islands. Falling barometer, shifting wind, and squally weather at some island outposts have often given the first warning of the birth of a hurricane. The large map shows a few of the island reporting stations.

To fill blind spots in the Caribbean the technicians of the Weather Bureau have experimented with automatic or robot weather stations. After much effort, together with the advance of electronics, an instrument has been designed and placed in operation at three stations in the vicinity of southern Florida. Two locations which would fill a gap adjacent to Florida were selected on Orange Cay and Dog Rocks, both uninhabited islands in the Bahamas. They are located on the eastern side of the Gulf Stream, both sites in a series of comparatively large rocks, affording elevations of from 10 to 35 feet above the sea and accessible only by surface vessel. The third station was located at Flamingo, Florida, a small fishing village

about 11 miles east of Cape Sable on the Florida peninsula.

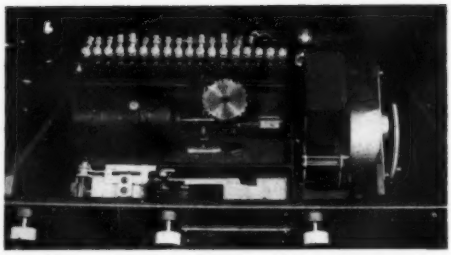
At the present time the three stations automatically transmit by radio. With the aid of an elaborate telemetering device they send the barometric pressure, wind direction, and wind speed prevailing at the time of transmission. Each station operates on a frequency of 3352.5 kilocycles, with a power less than 50 watts. The distance covered is from 65 to 125 miles. Time clocks automatically place the stations on the air at 15-minute intervals every three hours.

At the Weather Bureau offices in Miami and Key West, Florida, radio receiving sets of the latest type are located. The signals transmitted by the automatic stations are picked up by the receivers and translated on a waxed paper tape. The mechanism operating the tape feed is automatically started by an electric time clock which is synchronized with the time clocks at each of the transmitting stations. The location of duplicate receiving equipment at Miami and Key West was to insure the receipt of the maximum possible number of observations at all times.

The Orange Cay automatic weather station. The pole at the right of the picture carries the transmitting antenna.

After the observations are received and computed, the data are immediately placed on teletype circuits for use at forecasting offices and Weather Bureau stations.

Radio silence and other security measures during the war prevented regular collection of the usual ship and island weather reports. To fill the gap and once more provide protection to our growing military strength in the area, it was necessary to seek new sources of information. The military services themselves supplied the answer with aircraft weather reconnaissance. Specially equipped long-range aircraft, with experienced meteorological personnel aboard, were sent out on weather patrol. The patrols were of two kinds. In one case, routine tracks were established and regular daily flights were dispatched to make observations at fixed intervals. Usually the planes flew at low level on their way out, made an ascent to a higher fixed level at the halfway mark, and returned at that level. In this way the flights sought to provide both surface and upper air data. While in many ways they were not able to supply the same kinds of information afforded by the regular networks, they were invaluable in the absence of such reports.



Telemeter unit, which codes for transmission to the mainland stations the pressure, wind direction and speed, and call letters.

The second type of flight was made when a hurricane was known or suspected to exist. The aircraft would fly toward the probable storm area to scout its exact location and intensity. One of the earliest flights into a hurricane which has been recorded took place near the Texas coast on July 27, 1943, when Colonel Duckworth flew into the eye of the storm which moved inland over the Texas coast near Galveston and Houston. Since that time aircraft scouting of hurricanes has developed considerable skill and, in spite of the dangers and hardships, the crews of the ships on hurricane patrol give valuable information to help plot the storms and forecast their movement.

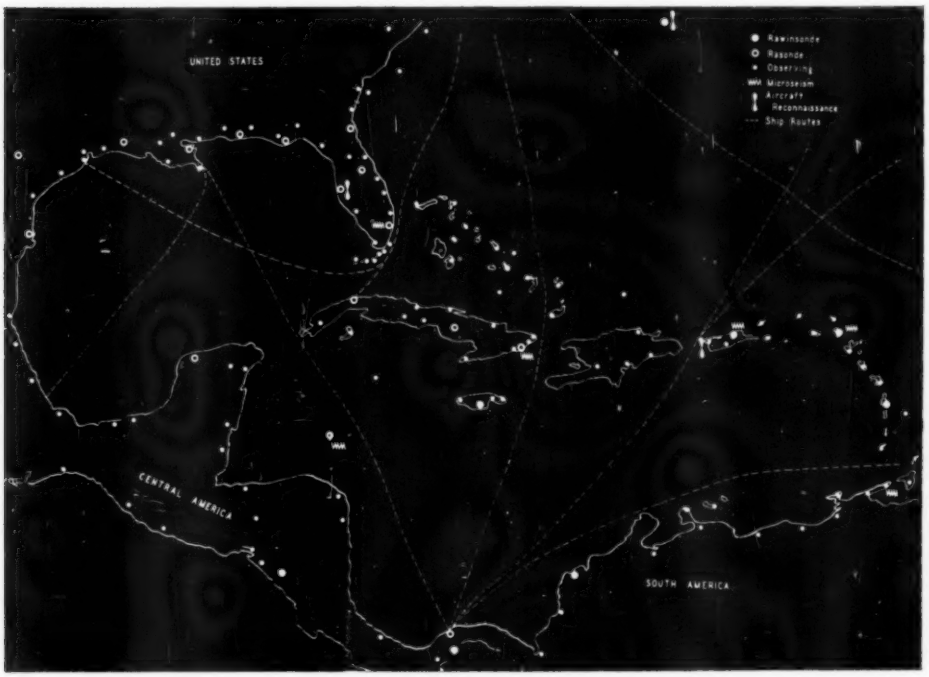
Although born of wartime necessity, the aircraft hurricane reconnaissance program is continuing to be an important part of the peacetime hurricane warning service. The storms often follow paths well away from the island stations. Ships at sea scatter before the storm to seek safety and often the

immediate vicinity of the storm is unreported. It is then that an aircraft, flying into or over the top of the storm, can keep a weather eye on its progress and relay the information to the forecast office. Both the Air Force and the Navy make available the long-range aircraft and experienced crews required to find and track storms under the direction of the Joint Air Force Navy Weather Bureau Hurricane Warning Central at Miami. Some of the bases from which the aircraft are flown are shown on the map.

The rasonde and the rawinsonde are beginning to contribute increasingly useful information to the forecaster to assist him in locating the first signs of the birth of a hurricane and in forecasting its probable development and movement. Complete stations of this type require more trained and experienced personnel and more and costlier equipment than are needed for the regular surface and ship reports. Observations of this kind cannot be taken very effectively aboard merchant ships. At present such stations are limited in this area to coastal and island locations. Because of the financial and personnel limitations, the number of stations is relatively small but the information is extremely important. Especially valuable are the upper wind reports obtained by rawin methods. Because they are not limited by cloudiness, as are the visual pilot balloon observations by theodolite, the observations by electronic means can be made during stormy weather and can go up to greater heights. From these reports the forecaster can determine the depth and strength of the major air streams in which the hurricane is traveling and can forecast its movement and anticipate changes in its path. Upper air stations operated by U. S. and foreign governments are shown below.

For the purposes of this article, the work of the hurricane warning service and the usefulness of the observations are divided into two parts: one, the locating and tracking of the storm, and the other, the forecasting of its future movement. It is obvious that all of the surface and upper air observations serve

(Continued on page 90)



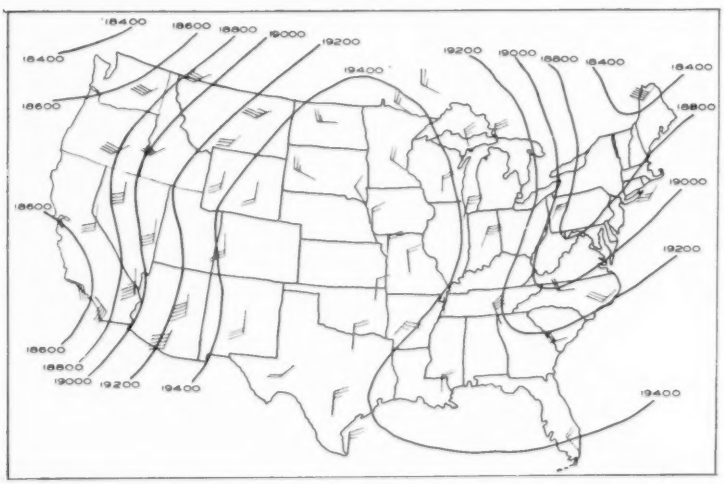
Some of the hurricane tracking and reporting weather stations in the Caribbean area.

The shaded areas show states in which precipitation was more than 100 per cent of normal during March, April, and May.

The Drought - Flood Story of the Spring of 1948

PERSISTENCE in weather patterns usually results in droughts, floods, heat, and cold, depending on the position of any locality relative to the particular region of blocking, stagnation, or persistence. Most famous recent example of this type of weather condition was the bitterly cold winter of 1946-47 in the British Isles and adjacent parts of the European continent. This was such a radical departure from the normal weather pattern in that area that records for cold and snowfall that had stood for a hundred years were shattered.

Why these abnormalities persist and why they build up or break down is probably one of the greatest problems confronting long range forecasters today. Here in the United States we have been treated to a rather mild example of persistence in a weather type which lasted all spring (March, April, and



Upper air conditions existing just before the breakup of this spring's persistent high pressure system. The figures give the height in feet of the 500-mb level.

May). It brought cold, wet weather to the northeast and northwest sections, and drought and above normal temperatures to a wide belt through the middle of the country. The surface chart shows graphically the results of this persistence on local precipitation, with all of the eastern states and most of the Far West, particularly the Northwest, decidedly above normal, but a wide strip from Texas to Canada with subnormal rainfall.

Significant in the maintenance of such a weather regime is the high-level condition depicted in the upper air chart. This is a typical 500-mb chart near the close of this period, but at a time when the wet-dry-wet bands were still maintaining themselves across the country. The chart shows the elevation of the 500-mb contour and the wind flow pattern in the free air at 20,000 feet. The great anticyclonic dome over the middle of the country coincides almost exactly with the area of subnormal precipitation, while the troughs to the east and west (with their strong southerly flow) cover the persistently wet sections.

This general condition finally changed during June, and we saw widespread and heavy rains throughout the Great Plains, with a return to a more normal weather progression across the country with hot and cool days, wet and fair periods following one another in a more normal pattern.

What a step ahead it will be when we can detect the establishment of these great blocking actions, determine how long they will persist, and when they will break down!

D.C.C.

TOP TEMPERATURES IN THE UNITED STATES

The highest temperature ever experienced in each state and the approximate location of the station that made the reading. From U. S. Weather Bureau data.

THE MERCURY has topped the 100° mark in every state of the Union. Only those areas along the immediate coastline of the Atlantic, Pacific, and Great Lakes shores, and perhaps a few mountain locations in the West, have not in recent times sweltered with the temperature at the century mark. Of all the major cities of the country, only two (Tacoma, Wash., and Miami, Fla.) can boast of two-figure maximums. The decade of the 1930's was responsible for creating many new state heat records. In 1930, 1934, and 1936, during a period of prolonged above-normal heat and deficient rainfall, 24 states equaled or surpassed the previous all-time highs; but it was the year 1913, a year of extended heat waves, that brought the highest reading for the entire United States. The following temperatures were recorded at Greenland Ranch, Death Valley, Calif. (178 feet below sea level) during July, 1913: 8th, 128°; 9th, 129°; 10th, 134°; 11th, 129°; 12th, 130°; 13th, 131°; and 14th, 127°. The minimum during this seven-day period was only 85°.

It appears that these figures are very close to the highest meteorological temperatures to be expected on the surface of the earth. The generally accepted all-time high is 136°, registered by an Italian observer in the desert about 25 miles south of Tripoli in North Africa. D.M.L.

Hurricane Detection by Radar

HARRY WEXLER, CHIEF, SPECIAL SCIENTIFIC SERVICES DIVISION,
U. S. WEATHER BUREAU

AN IMPORTANT ADVANCE in meteorology has been the development of radar and the discovery that it serves as a weather observing instrument. It is not known who was the first to find that certain echoes on the radar scope were caused by weather and not by aircraft. In any event, the significance of this new tool was quickly realized, and it was used to great advantage by pilots in avoiding areas of strong echoes as shown on the scope, since these usually, but not always, are associated with turbulence, rain, and generally poor flying weather. It was soon observed that non-precipitating clouds did not reflect sufficient energy to be indicated on the radar scope. This was ascribed to the small average size of the cloud droplets. Clouds from which drizzle and light precipitation were falling were also not discernible except at short distances, but clouds of moderate and heavy rainfall were almost always detected by radar within range of the set, provided attenuation was not too great.

It was found that many radar scope photographs reveal the existence of large-scale convective patterns whose presence is not suspected by observations of the local sky or by inspecting the synoptic weather chart. One of the most striking of these patterns is that of the hurricane. A limited portion of the trajectory of the hurricane of September, 1945, as determined by the weather maps and the path of the hurricane center as observed on the Orlando radar are shown in Fig. 1.

Fig. 2 is a photograph of the Orlando radar scope at 1630 EWT on September 15, 1945, when the hurricane center was 230 miles SSE of Orlando. Orlando is at the center of the polar coordinate grid. The central white area is caused by reflection from nearby ground objects as the radar antenna, directed horizontally, rotates about a vertical axis. Distances between circles are 20 miles each, and the total range is 120 miles. The azimuth angle is measured clockwise from north. The white arc or "band" is an echo from a squall line coming from the southeast. The band, which is a precursor of the approaching hurricane, moves rather regularly and maintains its shape. It is 130 miles long and from seven to 17 miles wide, traveling at about 35 miles per hour towards Orlando. Cellular structure is noted in its eastern portion. A scattered mass of echoes is seen to the west of Orlando. The dots on the scope are the result of interference and are not echoes from rain.

We may interpret the radar bands as regions where water droplets exist of a size and number large enough to cause reflection and detection of the incident radar beam. For these water drops to be formed and held in suspension until they grow so large that they fall to the ground as rain must mean that sizable upward currents are present. The radar bands thus indicate the presence of up-

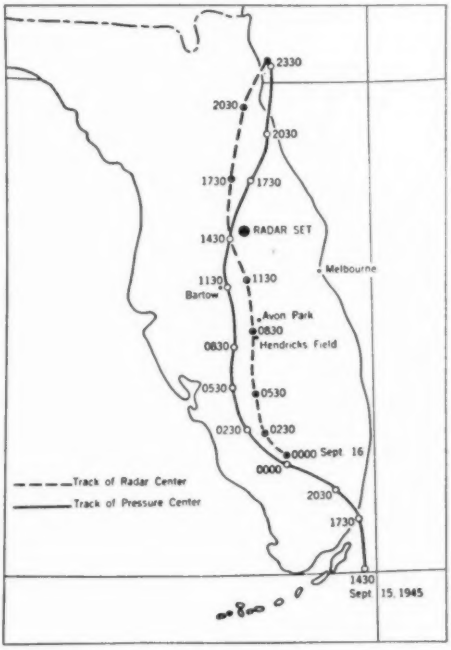


Fig. 1. Movement of the hurricane center over the Florida peninsula determined by radar and pressure.

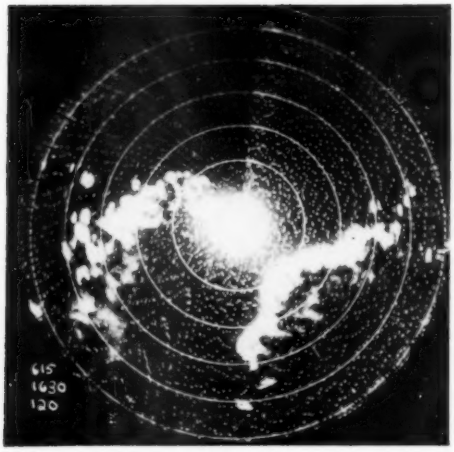


Fig. 2. The squall line in advance of the hurricane approaching Orlando, as shown by the radar scope on September 15th.

ward currents and the spaces between the bands indicate downward currents, although these intervening spaces may have shallow stratus from which intermittent light rain may be falling.

Fig. 3 is a photograph of the "off-set" PPI radar scope showing the hurricane at 0220, September 16th, when the center was 135 miles distant from Orlando at 175° azimuth. Note the striated structure of the radar bands about the center. These quasi-circular bands were first noted in radar observations of the "Great Atlantic Hurricane" of September, 1944, made at three different stations: Fort Monmouth, New Jersey; Lakehurst Naval Station, New Jersey; and the M.I.T. Radiation Laboratory at Cambridge, Massachusetts. Radar photographs taken of a Pacific typhoon in December, 1944, showed a very similar structure. Radar observations of subsequent hurricanes and typhoons have verified the circular band pattern, although there seems to exist a good deal of variation in the band structure not only from storm to storm but also within the same storm.

In Fig. 3, the location of the eye of the storm is distinctly visible. The descending currents characteristic of the eye would prevent formation of raindrops and, hence, the eye should be expected to appear on the radar scope as a clear area. No distinct eye was apparent in the photographs of the Florida hurricane, although quite small clear areas, less than 10 miles wide, were found near the center when the storm was first detected by the radar (Fig. 3). That the Florida hurricane of September 15-16, 1945, originally possessed an outstanding characteristic of a conventional eye upon leaving the ocean is verified by the observations of a 20-minute lull in wind speed at Carysfort Reef Light, Florida, and a 50-minute calm at Homestead Army Air Base, Florida, both coastal stations over which the center of the hurricane passed. The absence of a clearly defined eye when the storm came into radar range (about 90 miles inland), combined with lack of an intense inner band as observed in the Pacific typhoons, indicates that the central area of a hurricane is radically modified by even a short passage over land.

Weather reports enable the analyst to sketch in the isobars and thus find the point of lowest pressure. Only rarely, when wind and pressure observations are made in the eye, does the analyst have an opportunity to see whether the pressure center of the hurricane is also the center of rotation. Now the radar determines the center of rotation at successive positions. Much remains to be investigated, but it is clear that radar offers a very powerful diagnostic tool in hurricane investigation.

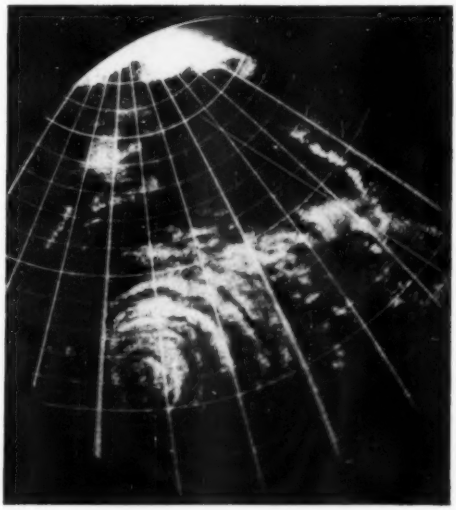


Fig. 3. The eye of the storm as it appeared on the PPI radar. Note striated structure of bands.

The mobile weather unit of the Air Weather Service on the highway in Pinkham Notch.

AWA Meets at Mt. Washington

THEODORE GIBSON, PHILCO RADIO AND TELEVISION CORPORATION

It rained and it poured, but the Amateur Weathermen of America loved it. After all, most of them had predicted it.

— REG ABBOTT
New Hampshire Morning Union

MEMBERS of the Amateur Weathermen of America commenced to arrive in Pinkham Notch by midafternoon, July 5th, for the first summer meeting of the society. The gathering was held at the Appalachian Mountain Club Camp in the shadow of New Hampshire's lofty Mt. Washington, long famous in New England as a natural weather laboratory.

The following morning, members of the 12th Weather Squadron, headed by Major Rogest Dively, put the finishing touches on the equipment in the mobile weather unit which the Air Weather Service had dispatched from Mitchel Field, Long Island, for demonstration of field facilities of the Air Force. The sun went in and out behind increasing low cloudiness, while the amateur weathermen frequently checked late reports in the mobile weather unit and tried to make optimistic predictions in spite of deteriorating weather observed on top of the mountain.

At 11:15 a.m., David M. Ludlum, director of the AWA, opened the meeting and briefly outlined the history of the society, and presented the program for the coming fall and winter. He pointed out the benefit to professionals and amateurs alike of the discussion of weather problems in the informal atmosphere provided by this and future AWA meetings.

Major Dively then discussed several phases of Air Weather Service activities, including:

Mobile weather stations. The equipment is so arranged in a truck or trailer that it may be operated immediately upon selecting a satisfactory site. Tinker Field, Oklahoma, is the headquarters for a new Mobile Weather Squadron among whose duties have been coordinating weather observations for atomic

Members of the AWA and friends who attended the first summer meeting at Mt. Washington. All photos by *Weatherwise* staff photographer.

bomb experiments. A mobile weather unit is being set up for display to the public at the opening of the new Idlewild Airport in New York City.

Facsimile service. Major Dively considers this new method of disseminating weather maps as the most important postwar development in meteorological field service. A central map analysis may be distributed by land wire or by radio to any number of field stations. Radio facsimile transmitters are now located at Miami, Fla., Wiesbaden, Germany, and Guam, for distribution of overseas sectional analyses. These maps are also received immediately at the Master Analysis Center in the Pentagon Building in Washington.

Weather training. Next in importance to briefing pilots on current weather is the distribution of all types of meteorological and climatological information to other units of the Air Force and the ground forces. Major Dively pointed out the opportunity for those subject to the draft to receive training for one year in basic meteorology. Present research in the Air Weather Service is largely directed to upper-air winds, since the demands of jet-propelled aircraft have greatly emphasized the deficiency of present methods of forecasting above 20,000 feet.

The Naval Reserve training program was presented by Lt. Com. Katherine Hammond, of the Naval Air Station, Squantum, Mass., where her principal duties are to brief reserve pilots and to train reserve personnel with no previous experience in weather. The two drill periods per month include training in the general duties of an observer, as well as some basic boot training. Commander Hammond stated that the facsimile map program is of tremendous assistance in view of the lack of trained personnel now available to the military services.

The last speaker on the morning session was Dr. Charles F. Brooks, professor of meteorology, Harvard University, and director, Blue Hill Observatory, Milton, Mass., who was one of the founders of the present Mt. Washington Observatory. For the past 15 years, Dr. Brooks has made a study of the relation between Mt. Washington weather

and that of Boston, and he presented the results of this study in a fascinating discussion. He has found that a strong northwest wind on the summit while a storm is approaching from the west or south will usually mean little precipitation at Boston during the next day or two. If the mountain wind decreases rapidly and the temperature rises, then Bostonians had better carry their umbrellas. He analyzed the recent weather activities in the region and presented the general trend of the weather for the next day or two, all based on the fact that northern New Hampshire weather is directly discernible from the weather atop the White Mountains.

At the close of Dr. Brooks' morning discussion, mountain appetites were treated to an excellent meal served by Joe Dodge, an AWA and AMS member, who operates Pinkham Notch Lodge for the Appalachian Mountain Club.

After the noon meal everyone inspected the mobile weather station and its fine equip-

Major Dively describing the activities of the mobile section of the Air Weather Service.

ment: instrument and hydrogen shelters, theodolite, plotting board, hydrogen and electricity generators, and a wealth of communication equipment. Main interest centered in the interior of the truck where facsimile, radio, and teletype equipment was on display. A quick glance at the low deck of stratus showed that soon a WW 64 condition was about to occur. There was just time to snap a hurried group photograph and then retire to the lodge for the afternoon talks and demonstrations.

The first speaker was G. Dawson, representing the weather bureau of the Malden High School (see WEATHERWISE, February, 1948, Vol. I, No. 1). He presented a brief history of the meteorological program there and told how many former students were now pursuing meteorology as a career.

The chairman then commented on the development of meteorological programs at other high schools, making special mention of units in Milwaukee, Albuquerque, and Atlantic City. At East Charleston, Vermont, a complete weather station has been established at Camp Winape, where the campers forward their observations weekly to the AWA headquarters. In Philadelphia, the city planning commission is sponsoring a project to establish a small observatory, equipped with a maximum-minimum thermometer, a rain gauge, and an anemometer, at each high school in the city. Their data will be of value to the planning commission, city engineers, and fuel oil dealers.

The early history of the Mt. Washington Observatory was next most interestingly traced by Dr. Brooks. Back in 1870, Dartmouth College assisted in establishing an observatory, which was soon taken over by the U. S. Signal Corps and operated until 1887. Observations were resumed spasmodically, mostly in the summertime, until 1931. As part of the International Polar Year, upper air soundings were resumed, and the next year saw a permanent station established with complete observing facilities. The efforts of the volunteer observers were greatly implemented in 1935, when the U. S. Weather Bureau assigned permanent personnel to the mountaintop.

Dr. Brooks described the buildings which were constructed to withstand winds of 250 miles per hour. He reported that the 1938 hurricane was clocked at 189 miles per hour; this was of sufficient force to shift one-half mile of track of the cog railway. In 1934, a maximum instantaneous speed of 231 m.p.h. was recorded on a special anemometer.

Then Dr. Wallace Howell, acting director of the observatory, spoke on the research work now being carried on and mentioned projects in the planning stage. In the first days of the station, personnel confined their work to purely meteorological activities. Many instruments, ordinarily employed at a

surface station, had to be redesigned for operation at the 6,200-foot level. Special wind speed and direction units were created with de-icing characteristics and capable of operating at high speeds. Precipitation gauges had to trap some of the moisture that would be sucked out of regular gauges. Barometers needed special housing to compensate for the venturi effect of very high winds.

Work on Mt. Washington now includes many problems faced by modern aircraft in flight. Icing problems have always been foremost, and now the operation of jet engines under arctic conditions is being studied. Progress has been made in the development of instruments to measure drop size and distribution of precipitation nuclei in clouds, but much remains to be done in this field.

The climax of the meetings was a demonstration of a General Electric cold chamber for creating snow crystals. Ray Falconer, who has spent four years atop Mt. Washington, substituted for Vincent Schaefer, who is currently in the West investigating lightning strikes in national forest areas and their possible prevention by weather control methods. Mr. Falconer showed the usual dry-ice technique of producing ice crystals, and also produced the same effect by a sudden expansion of air induced by a simple homemade popgun.

A group discusses operation of a rasonde instrument from the mobile weather unit. From left to right: Dr. J. Q. Stewart, Dr. Brooks, Major Dively, Lt. Com. Hammond, Joe Dodge, Kenneth Spengler, and David Ludlum.

The continuous moderate rain prevented any outdoor activities, although the Air Force men did succeed in releasing a rasonde and several ceiling balloons. The former was tagged and, if returned, the finder will receive a handsome barometer as a prize.

To conclude the activities of a busy day, several of the speakers made the ascent to the top of the mountain, where a broadcast was made over WNAC and the Yankee Network describing some of the highlights of the first AWA summer meeting.

The Daily Weather Map

THE PRINTED daily weather map published by the United States Weather Bureau at Washington, D. C., has recently been revised, and is in a form that should be both interesting and useful to all amateur weathermen. In its present arrangement, it consists of a large-scale surface weather map of the United States, with weather data plotted for nearly 200 stations. The analysis includes fronts and isobars, precipitation areas, the freezing and zero-degree isotherms, and the designation of highs and lows and air masses. In order to provide continuity, there is also a small-scale surface weather map for 12 hours previous to the large map, showing the entire continent of North America. No station models are plotted on this map, but the analysis is given as on the large map.

In addition, there are three small maps of the United States, one giving the daily maximum and minimum temperatures, one showing 24-hour precipitation areas and amounts, and one portraying a 700-millibar constant pressure chart. An explanatory station model is included, and brief paragraphs of general weather information and forecasts for the vicinity of the subscriber.

A complete and detailed explanation of the weather map is often printed on the back of the chart. At other times special charts or articles dealing with various phases of Weather Bureau activities take its place.

ED. NOTE: To subscribe to the daily weather map, make application with post office money order or check, payable to the Treasurer of the United States; and mail to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price: daily including Sundays and holidays, 30 cents a month, $3.60 a year.

FLYING the weather map

Studying Hurricanes from the Inside

R. H. SIMPSON
U. S. WEATHER BUREAU

MARINERS AND SCIENTISTS have been observing the behavior of Atlantic hurricanes since the year 1494. But most of these observations have been made from the surface, so that the violence of the storm itself usually has obscured the inner mechanisms which drive the storm forward and are responsible for the localization of such a superabundance of kinetic energy in the atmosphere. Scientists, in trying to arrive at a reasonable picture of the structure of a hurricane in years gone by, have had to do so by projecting and extrapolating a small amount of surface data more or less blindly into the middle and upper troposphere. Recently, however, electronic developments have broken through the barriers which cloak the hurricane and have made it possible to look up through the cloud and rain into the heart of the storm, to take its pulse and to observe to some extent its inner workings. This has been made possible by use of radar and rasonde equipment.

Even the use of these devices, however, has failed to provide the answer to many questions about the hurricane structure. The rasonde must be borne aloft by a free balloon to radio back to the surface station information on pressure, temperature, and humidity. When the storm winds arise it is difficult to release the balloon. Only two such releases have been made in the "calm" center of a hurricane where winds are relatively light, and there was no assurance then that the balloon while rising remained in the center. The relatively limited range of most radars also made it difficult to study more than one sector of the storm at a time from a land station.

It was agreed between the Weather Bureau and Air Force, therefore, that several experimental reconnaissance flights should be made into the first large hurricane of 1947, using a B-29 to study at close range the temperature and cloud structure, especially of the upper part of the storm, and of the eye or region of central calm. The writer represented the Weather Bureau on two of these flights into the severe hurricane of September 12-20, 1947. Some of the experiences on these flights are recounted below.

Early in the morning of September 14, 1947, our B-29, completely modified for weather reconnaissance and heavily loaded with gasoline, took off from Kindley Field, Bermuda, which is USAF headquarters of the 53rd Weather Reconnaissance Squadron. There were 10 persons aboard, including the regular crew of nine and myself. At that time the hurricane, which had swept in from the Cape Verde region of the Atlantic and passed north of the Antilles Island chain, was about 675 miles east-southeast of Miami, Florida, presumably moving west-northwestward. On this first flight, it was planned to top the hurricane and fly diagonal courses at high levels across the center, spiraling down into one quadrant and up through another so as to measure the temperature lapse rate conditions on all sides of the storm center.

As we left Bermuda, we soon reached several lines of shower clouds which did not seem associated with the hurricane. Immediately beyond, an area of very fine weather was found with little if any clouds. This area, probably 150 miles wide, extended ahead into the region where the upper shield or canopy of cirrostratus marking the edge of the hurricane was rising rapidly on the horizon. After proceeding 30 to 40 miles under this shield toward the storm center, a spiral climb was begun in an attempt to top the clouds. It had been expected that most storm cloudiness except a few

This photograph was taken toward the center of the hurricane on September 16th, before engine troubles forced termination of the flight plans. The plane was at 20,000 feet, at longitude 74° west, latitude 30° north, 275 miles from the storm center. Air Force photo.

cumulus towers and some strands of cirrus near the center could be topped at 30,000 feet. After climbing to 20,000, then to 25,000, it began to be apparent that the top of the storm was much higher than had been anticipated. At 30,000 feet, we had just reached the base of the cirrostratus cloud shield. An additional climb brought us out on top at a little over 36,000 feet, which was about as high as the plane could safely operate. Looking toward the storm center, it became immediately evident that we could not remain on top because the cirrostratus rose up sharply in that direction.

A decision was reached to probe ahead toward the center according to the original flight plan, but depending upon radar reflections of the storm rain area to avoid turbulent cumulonimbus clouds and to locate the storm center. In this connection, it probably should be explained that during the war it was discovered that rain echoes from large tropical cyclones, as picked up by radar PPI scopes, usually conform to a characteristic pattern consisting of bands of precipitation or an alignment of rain cells which spiral inward toward the storm center. [See page 79 for radar patterns of a hurricane in September, 1945.]

As we moved into the north sector of the storm completely on instruments, it became necessary to fly quite a zigzag path in order to avoid cumulonimbus towers which rose up to plane level and disappeared in the cirrostratus overhead. At times we came close enough to these towers to be certain they extended many thousands of feet above our 36,000-foot flight level. Visibility in the cirrostratus at such times appeared to be about one and one half miles, but at no time were there definite breaks in the cloud sheet through which the plane was flying. Once, however, the cloud thinned sufficiently that an unusually brilliant solar halo of 22 degrees was observed.

The radar echoes received at 36,000 feet were sufficiently strong to allow safe navigation around the taller cloud towers, but the range was so limited that some difficulty was experienced in locating the center. It was spotted first to the east while the plane was moving southward and the course was changed to allow a circumnavigation of the center. As we moved first eastward then northward about the center, additional echoes were picked up by radar and the plane's position ascertained by loran to provide a definite fix.

With this much accomplished, it was necessary to abandon the rest of the flight because of two unexpected developments; first, the unexpected climb to 36,350 feet had run the gas supply low, and second, a considerable amount of ice had accumulated on the wings of the plane, thus narrowing the gap between the indicated airspeed and that of stall. This ice accretion remains a curious thing, most of it accumulating at a true temperature of −35° C. or colder. It seemed to be a rime-type ice which could form only in the presence of supercooled water droplets.

Cloud structure in advance of the storm on the 16th, taken from just off the coast of Florida, at 25,000 feet. The center of the storm is to the left, 310 miles away. Air Force photo.

The trip back to the base was uneventful and most of the crew felt somewhat downcast at not being able to carry out the entire mission, but it allowed time to reflect upon several interesting facts brought to light during the trip: 1. that the cloudiness of the storm extends well above 36,000 feet, probably exceeding 45,000 to 50,000 according to estimations of light overhead; 2. that the top of cirrostratus clouds rises prominently as the storm is approached; 3. that no sector of the storm seemed to have a minimum of cloudiness on that day (the storm was moving slowly at this time); and 4. rime icing was observed at 36,000 feet at a temperature of −35° C.

The second trip was made September 16th, at which time the hurricane had moved into the Bahama Island area and was poised, undecided whether to continue its westward march or to sweep rapidly northward to involve the Atlantic seaboard. The B-29 used for this trip was new and equipped with extra gasoline tanks to allow longer hours in the air. The flight plan called for an approach to the storm center at intermediate levels to observe the variation in cloud structure and turbulence in connection with radar patterns, then for an ascent to the ceiling of the plane, at which level an attempt was to be made to penetrate the eye of the storm and circle down into the cloudless central vortex photographing the clouds and measuring changes in temperature and pressure.

As the plane approached the storm at 10,000 feet, the cloud sequence was similar to that on the first trip except the cirrostratus cloud shield extended out much farther and lines of rain clouds were visible in the radar much earlier. This time the flight continued toward the storm center at 10,000 feet until three of these lines had been crossed. Then the course was changed to become parallel to the radar bands and directly between two of them. Soon the

cloud sheet overhead lowered almost to plane level and light rain occasionally fell from it.

Surprisingly enough, there were very few clouds beneath the plane. The flight was being made down a canyon in the clouds with huge convective walls, along the area where radar was picking up heavy precipitation echoes, rising to either side and disappearing into the cloud sheet overhead. A descent was made to 7,500 feet in order to stay out of the lowering cloud sheet above us, but a course was maintained parallel to the bands of precipitation echoes, corrections being made in our course as required by the curvature of these lines. Horizontal visibility was gradually reduced by the light rain, and the thickness of cloud overhead was made impressive by steady darkening of conditions as less and less light was able to filter through the clouds. Without the aid of radar, it would have been difficult to follow visually the canyon in the clouds down which the plane continued to fly until a point little more than 100 miles north of the storm center was reached. Here it appeared that the lines of convective clouds began to merge into almost a solid wall of cloud and rain concentric about the eye of the storm. By again using radar to navigate, a "weak spot" was found in the outer convective line nearest the plane, through which it was possible to fly and remain virtually free of cloud and turbulence. The relation between cloud and turbulence was the factor of greatest significance in this portion of the flight. From the time the plane started its flight down the cloudless avenue between the convective cloud bands, until it reached the point nearest the storm center, **no appreciable turbulence of any kind was felt.** Yet, below the plane, heavy seas gave ample evidence of the storm's violence, and winds at plane level were 45-50 knots. The only turbulence worthy of note occurred during the crossing of the convective bands in the initial phase of the flight. To crew members of this flight who had on previous occasions experienced severe turbulence for considerable periods while trying to "plow through" directly to the storm center without benefit of radar, this absence of turbulence was incredible and seemed to suggest new and safer methods of hurricane reconnaissance in the future.

For the second phase of the flight, a retreat was made to a point near the outer edge of the cirrostratus shield where the climb was begun. After reaching 36,750 feet, the base of the cirrostratus had still not been reached. The storm had grown both horizontally and vertically since the flight made on September 14th. A course was set to carry the plane into the eye of the storm, where it was hoped that conditions would favor the descent described previously. At this juncture, however, fate took hold in a fashion that caused us to alter our plans quickly. An unexpected and eerie yawing of the plane was followed by a terse report from the scanner that number four engine was belching black smoke; almost immediately a similar report was made of number one engine. The fight which followed to keep the plane in the air with only two good engines was an experience that will not soon be forgotten by those aboard. Suffice it is to say the crew exhibited the kind of courage and skill, battling this difficulty, that measures up to the best traditions of the Air Force. A new course was set for Drew Field (Tampa, Florida), at that time over 400 miles away. The long glide was made successfully and the plane landed safely.

Much of the data which we hoped to collect was not obtained due to failure to complete our flight plans. However, the information on icing and turbulence, and the discovery of the extent and orientation of the cloud system around the storm are in themselves of sufficient interest and importance to justify the flights. Such reconnaissances as these in the future may serve to fill in most of the remaining gaps in our understanding of hurricane structure and the factors which govern its movement.

Drawing by
Eric Sloane

THE ORDINARY HOUSE CRICKET is a saltatorial orthopterous insect of the Gryllidae family, and besides all that he is a very good vocal thermometer. Long before the invention of the thermometer by Galileo in 1593, and the formulation of the present scale by Fahrenheit in 1714, these small insects were chirping away on late summer evenings at a rate directly proportional to the temperature. Last August and September a research team was sent into the field by the AWA to test the accuracy of the findings of Bert Holmes of New Haven, Conn., who some 20 years ago first studied the tempo of chirping. Like most things in nature, the formula is quite simple. One cricket, when interviewed, explained his thermodynamic activities this way, "Just count the number of my chirps in 15 seconds and add 37 to that figure. If the sum is not the temperature in Fahrenheit within one degree, I'll resign my professional membership in the AMS."

It has been suggested that this new thermal unit be designated the "Krick," but considerable controversy has arisen over the propriety of this and as to whether it should be expressed in Fahrenheit, centigrade, or Reaumur. The whole subject has been referred to a committee of the International Meteorological Organization and a report is expected at the end of the next Brueckner cycle.

D.M.L.

WORKSHOP FOR WEATHERMEN

CONDUCTED BY CHARLES A. LAIRD

How to Construct a Density Channel

THE DRAMA of clashing air masses and the interaction of cold and warm fronts may now be brought right into the classroom. By means of a density channel, which is simple to build and easy to operate, one can effectively simulate on a small scale the gigantic forces of the earth's atmosphere. We are indebted for the following plans to A. L. McCuistion, chief meteorologist, Spartan School of Aeronautics, Tulsa, Okla. Mr. McCuistion calls his device a "fishbowl" and has employed one in his classes for many years.

The ends and bottom of the tank are of 20-gauge galvanized iron, in one piece bent as shown in the diagram. Use ⅛ x ¾ x ¾-inch angle iron for the frame, welded or soldered together. The vertical brace straps are of iron 1″ by ⅛″ thick, welded flush as shown.

The side plates are made of clear glass approximately ¼″ thick, sealed in and made watertight with putty. Two partitions are placed so that three compartments of approximately equal volume are formed. The partitions may be cut from 0.020″ Alclad aluminum or similar material, and they should slide easily but snugly in guides made of strips of ⅛″ plastic or glass, cemented with waterproof glue to the sides and bottom. The metal parts (except partitions) should be covered with white waterproof paint.

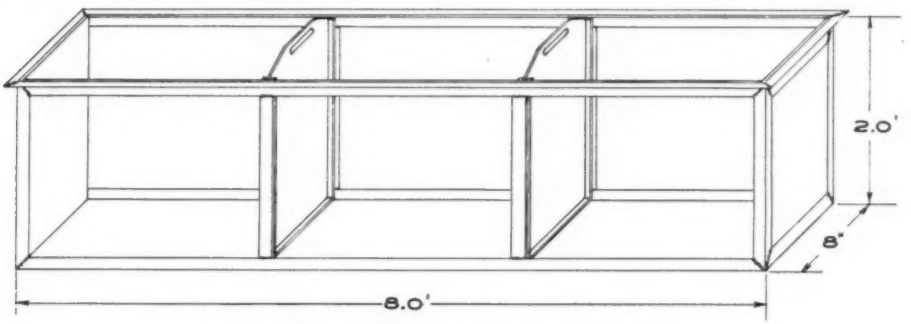
With the completion of the "fishbowl" all that is needed for the demonstration is water of different densities. No change from normal need be made for the water in the central or neutral tank. The lefthand tank is filled with water containing two generous spoonfuls of salt, while the water in the righthand tank is made less salty with only one spoonful of salt. For easy identification add several drops of red ink to the

A. L. McCuistion demonstrates how frontal action is simulated in his "fishbowl."

righthand or less salty water, and this will represent the warm air mass. Add blue ink to the salty, lefthand solution to show the cold air mass. Thus are formed two bodies of water of different densities and colors separated by the colorless section containing water of the least density of all.

Allow the tank to stand quietly until the water is motionless and then raise the partition holding the red solution an inch or so. This will permit

(Continued on page 89)



Details of the construction of the density channel tank.

FIRE

George R. Stewart. Random House, New York, 1948. 336 pages. $3.00.

WHEN GEORGE R. STEWART wrote **Storm,** the saga of a cyclone named Maria, he made history in the field of science writing in general, and particularly in the field of meteorology. Now his book about Spitcat, the forest fire, demands equal attention, not only for the sheer beauty of its workmanship, but for the scientific precision with which it traces the inexorable steps from a spark kindled by a lightning flash to the flaming monster which, in 10 days, takes lives of men and woodland creatures, destroys the centuries-old majesty of thousands of acres, only being subdued when a rain-producing combination of weather elements becomes allied with man.

No one who reads this book can escape an awareness that fire-weather service is one of the most vital functions of the Weather Bureau. There will be wider understanding and deeper appreciation of the awful significance of weather in terms of the almost military struggle between man and flame.

For the casual reader, **Fire** will be an exciting experience. For those who are weather-minded there will be even greater interest because here they will find the behavior of the air written about in a manner which not only commands the respect of those who know the science of it, but also of those who savor the richness of simple, vivid description:

"He must see fire in terms of a spinning earth and a sun retreating toward Capricorn, of arctic against tropic and continent against ocean, of the flying spray from Pacific waves whipped up by winds and absorbed by thirsty air a thousand miles off-shore."

"Even while the boys were at work, however, conditions were changing. The heat of the high sun began to establish an up-draft in the canyon, and the approach of the storm-front reinforced this southerly breeze.

"First came a little puff, and then a long sigh, as if something gigantic were letting out its breath. The smaller branches swayed gently. The tufts of flame wavered and spiraled, and then leaned over and stayed that way."

". . . . The air, cold and dry already when it had moved in behind the storm-front, had grown colder during the clear night, and having had most of its

"This book puts life into the subject of weather observing . . ."

— Professor H. R. Byers, Acting Chairman, Department of Meteorology, The University of Chicago

TECHNIQUES OF OBSERVING THE WEATHER

By BENARTHUR C. HAYNES, Chief, Observation Section, U. S. Weather Bureau

This practical book tells you exactly how to gather the data necessary for weather forecasting. The author treats means and methods of observation thoroughly, and gives detailed instructions on the use of instruments, charts, and forms.

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remaining moisture squeezed out as frost, it was also even drier than before. This dome of cold and heavy air, extending upward some thousands of feet, rested upon a plateau which was several thousand feet above sea-level, in eastern Oregon and the adjoining parts of Idaho and Nevada.

"Only a few hundred miles to the southwest, in the low-lying Central Valley of California, the temperature had reached a hundred degrees in the afternoon, and had scarcely fallen below eighty during the night. The air was correspondingly light, and it rested on a surface only a little above sea-level.

"Lacking a barrier, the heavier air must by the mere law of gravity, run down and replace the lighter air, and the only semblance of barrier between the two was the line of the northern Sierra Nevada. In ancient days, however, that edge of the tilting block of earth which had formed above those mountains had been lifted only a few thousand feet above the level of the eastern plateau, and during the hundreds of centuries since its up-lifting the forces of air and water and frost had worn down gaps and passes which were scarcely a thousand feet above the sagebrush plain. The line of mountains, therefore, in comparison with the high-towering cold air, was little more than a picket-fence to ruffle the under surface. Before daylight a dry cold wind was beginning to pour through the passes and down the long canyons of the western slope."

" . . . . Dry at the beginning, that air grew drier still as it flowed down the slope and grew warmer. It licked up thirstily the few drops of rain and the little dampness of the night. It robbed the plants of hard-won moisture sucked up from deep in the ground. Leaves wilted in the bitter-brush and mountain-lilac; turpentine distilled from the pines; on the forest-floor the needles were crackling dry."

In passages like these, Stewart tells the story of Spitcat with imagery that is literally and figuratively fiery. This book is a literary treat, made more meaningful by the knowledge that its science is sound. A new picture of weather wisdom is inevitable after reading it.

ARMAND N. SPITZ
The Franklin Institute
Philadelphia, Pa.

WORKSHOP FOR WEATHERMEN

(Continued from page 87)

the warm-air-mass water to flow across the bottom of the central section. Just as it reaches the center, release the cold-air-mass water in similar fashion. The effect, when they meet on the floor of the tank, is that of a cold front rushing into the region, underrunning and displacing upward a retreating warm air mass.

An alternative to the use of salt solutions, but which is probably more difficult to operate perfectly, is to heat or cool the water. Naturally, the coldest water will represent the cold air mass, but to retain the stratification effect the warmest water should be that in the central or neutral section. Otherwise rapid mixing of the water may take place.

Practical Meteorology

WEATHER AND MAN

By Hans H. Neuberger and F. Briscoe Stephens, The Pennsylvania State College

Non-technical theory and "everyday" applications are skillfully combined in this fascinating study of weather phenomena. The first twelve chapters present a sound, fundamental concept of meteorology based on air mass analysis with a minimum of technical detail. The rest of the book shows the effects of weather conditions on home and professional activities — such as agriculture, transportation, health, housekeeping, etc. — with a unique treatment of weather lore, weather gadgets and devices.

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(Continued from page 75)

both cases although the aircraft reconnaissance data tend more to help in locating and tracking and the upper air data more in forecasting. There are other types of observations in, or beginning to emerge from, the experimental stage whose usefulness is almost entirely in finding and tracking. These are sferics, microseisms, and radar.

Sferics (or spherics, taken from atmospherics) are observations of the location of centers of propagation of atmospheric electricity or static. It has been found that certain atmospheric disturbances generate and discharge considerable static electricity, even when no visible lightning is present. Coordinated direction-finding observations of these centers of action are called sferic observations. Much work remains to be done in completely undestanding the relationship of these phenomena to hurricanes. Observations are being collected for study.

Seismologists have observed that storm centers, particularly when moving over water, produce measurable ground waves that are recorded as microseisms on their delicate seismographs. By careful measurement of time at closely calibrated tripartite stations, a bearing can be made on the center of the disturbance. Two or more such bearings, measured at widely spaced tripartite installations, fix the location of the generating source. There is not complete understanding of the relationship between the generating source and the center of the hurricane. However, experience to date encourages the students of this method to optimism regarding its usefulness as an aid in locating storm centers in areas where there are no weather observations and in following their progressive movement. The location of the seismological equipment under this program is indicated on the large map.

Radar is being used in two ways in hurricane work. Airborne sets are used, particularly in night reconnaissance flights, to spot the precipitation patterns peculiar to tropical cyclones. Radar has assisted the airmen to locate and report the center without actually flying into it. In much the same way it is hoped that land-based sets will help locate and track storms. While the range of radar is very limited compared to sferics and microseisms, the accuracy is greater and it is expected that as more sets are used for this purpose along the coast and in the islands, the chances of storm winds beginning without ample warning will be greatly reduced.

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Weather Exchange

Classified advertisements for this column are 8 cents a word, including address; minimum ad 20 words. Remittance must accompany orders. Write Weatherwise, AWA, The Franklin Institute, Phila. 3, Pa.

WIND VELOCITY INDICATOR: direct-reading, remote-indicating; 0-100 mph scale; ideal for amateur weather observer. Complete, with 50-foot lead-in wire, $49.95 postpaid. Immediate shipment. Cape Wind-Indicator, Harbor Road, Harwichport, Cape Cod, Mass.

FOR SALE: Friez triple register to record wind direction and speed, duration of sunshine, and duration and amount of rainfall. Excellent condition. Best offer accepted. Box 21, Weatherwise.

FOR SALE: Equatorial mountings for Weather Bureau instruments, with motor drive on polar axis such that the instrument follows the sun. Price of mounting for pyrheliometer tube $135.00. Price of mountings for water-vapor spectroscope quoted on request. C. C. Young, 25 Richard Road, East Hartford 8, Conn.

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These modern teaching aids, developed for the U. S. Navy, are ideal for use in the classroom on each student's desk. They depict in color a weather map over an area 800 miles wide and 1,000 miles ahead. Size of each is 9 x 10⅛ in. As the cover opens, a series of vertical cardboard vanes stand up, giving a true three-dimensional representation of weather phenomena. Each vane illustrates and diagrams a storm stage. Flying advice and discussion of typical situations is given.

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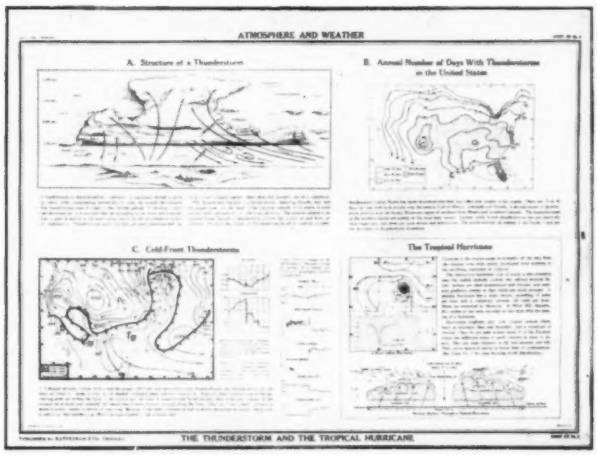
Atmosphere and Weather Charts by Glenn T. Trewartha. Eight charts. Size 49" x 38".


ATMOSPHERE AND WEATHER
A. Structure of a Thunderstorm
B. Annual Number of Days With Thunderstorms in the United States
C. Cold-Front Thunderstorms
The Tropical Hurricane
THE THUNDERSTORM AND THE TROPICAL HURRICANE

AW1 Vertical Cross Section of the Atmosphere and Winds
AW2 Air Masses and Fronts
AW3 Vertical Air Movements, Temperature Changes, and Clouds
AW4 Atmospheric Moisture
AW5 The Middle Latitude Cyclone
AW6 The Thunderstorm
AW7 Weather Conditions related to Aircraft Icing
AW8 United States Daily Weather Map

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